SBEACH High-Frequency Storm Erosion Model Study for Sarasota County

Final Report

by

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1. **Background**

High-Frequency storm tide studies have been conducted by the Beaches and Shores Resource Center (BSRC) for 14 of the 24 CCCL studied counties since 2009. Hydrographs with return intervals of 15- and 25-year were developed for the application of dune erosion models and are available through the BSRC website at: *http://beach10.beaches.fsu.edu/index.html*. Due to increased usage of SBEACH (Storm-Induced BEAch CHange) by coastal engineers for coastal projects in Florida, the Bureau of Beaches and Coastal Systems (BBCS) of Florida Department of Environmental Protection (FDEP) has contracted with the BSRC to conduct the model calibration and application on a county by county basis. At present, SBEACH model studies have been completed for six counties: Walton , Okaloosa, Brevard, St. Johns, Volusia and Indian River by Leadon and Nguyen (2009 and 2010). As a result, the SBEACH model for high-frequency storm event is currently used in project ranking for beach management program, verification for armoring project and shore/dune protection project permit application.

The SBEACH model developed by the U.S. Army Corps of Engineers (USACE), is an empirically based numerical model for predicting short-term profile response to storms. The SBEACH model calculates beach profile changes with emphasis on beach and dune erosion and bar formation and movement. It is a cross-shore sediment transport model so the longshore processes are considered to be uniform and neglected in the calculation of profile changes. The model was initially formulated using data from prototype-scale laboratory experiments and further developed and verified based on some field measurements and sensitivity testing (Larson and Kraus 1989, 1991; Larson, Kraus and Brynes 1990).

To accurately apply the SBEACH model for a high-frequency storm event, it is essential to have the model calibrated in the project area under the similar storm conditions. This requires detailed pre- and post-storm beach profile surveys that represent a storm's effects upon cross-shore beach change and coincident information regarding the wind, wave and water level conditions. This study presents eroded dune and beach profiles due to high frequency storm events with return intervals of 15 years and 25 years in Sarasota County using the latest version of the SBEACH model. All data resources for calibration and input files required to run the SBEACH model are documented.

2. Model Calibration

Searches for available surveyed beach profiles associated with a tropical storm or hurricane for Sarasota County resulted in a limited data set with sufficient completeness and quality for model calibration. It is found that a set of beach profiles in part of Sarasota County were surveyed before and after Hurricane Gabrielle of 2001. The model calibration became possible with the help of BSRC's 2-D surge model to make up for the lack of measured storm tides on the open coast.

2.1 Storm Data

Tropical storms and hurricanes since 1900 that passed within a 50 mile radius from the center of Sarasota County are listed in Table 1. Hurricane Gabrielle of 2001 is the only storm among these 18 storms with sufficient pre- and post-storm surveys for calibration purposes. The BSRC 2-D Storm Surge Model generated storm tide hydrographs which were then used as input for SBEACH.

Table 1 Summary of Historical Storms Affecting Sarasota County

Storm	Date	Name	Type*
1	8/2/1901		E
2	8/7/1928		A
3	8/29/1930		L
4	7/25/1933		E
5	8/29/1935		A
6	10/12/1944		L
7	9/3/1945		A
8	9/28/1951	HOW	L
9	10/7/1953	HAZEL	L
10	6/18/1959		L
11	10/17/1959	JUDITH	L
12	8/29/1960	DONNA	A
13	6/1/1968	ABBY	L
14	11/17/1988	KEITH	L
15	10/9/1990	MARCO	A
16	9/11/2001	GABRIELLE	L
17	8/9/2004	CHARLEY	L
18	7/22/2010	BONNIE	E

* L: Landfalling ; E: Exiting; A: Alongshore

Hurricane Gabrielle was a moderate category 1 hurricane which made landfall near Venice, Florida as a strong tropical storm with winds of 70 mph. Gabrielle developed from a non-tropical low-to mid-level trough on September 11, 2001 in the southeastern Gulf of Mexico. Weak steering currents caused Gabrielle to meander offshore of Florida, while strengthening slowly. Developing into a tropical storm, Gabrielle made landfall in southwestern Florida. Crossing Florida, Gabrielle emerged into the Atlantic, where it further strengthened into a hurricane. Hurricane Gabrielle weakened back to a tropical storm shortly thereafter, and became fully extratropical on September 19, 2001. Storm track plotted with data from National Hurricane Center is shown in Figure 1.

2.1.a Storm Tide Data

For the purpose of model calibration, the measured storm tide and wave data generated by Hurricanes Gabrielle are essential. However, the only available measured water elevation data was from a National Ocean Service (NOS) tide gage located at Naples, Collier County. The BSRC's 2-D Storm Surge Model has been verified throughout the CCCL studies and various storm events and has been proven to be an accurate and reliable model (Dean, Chiu and Wang, 1988). The 2-D Storm Surge Model was run using Collier County bathymetry data and Hurricane Gabrielle storm data to generate a storm tide for Naples. Figure 2 shows the

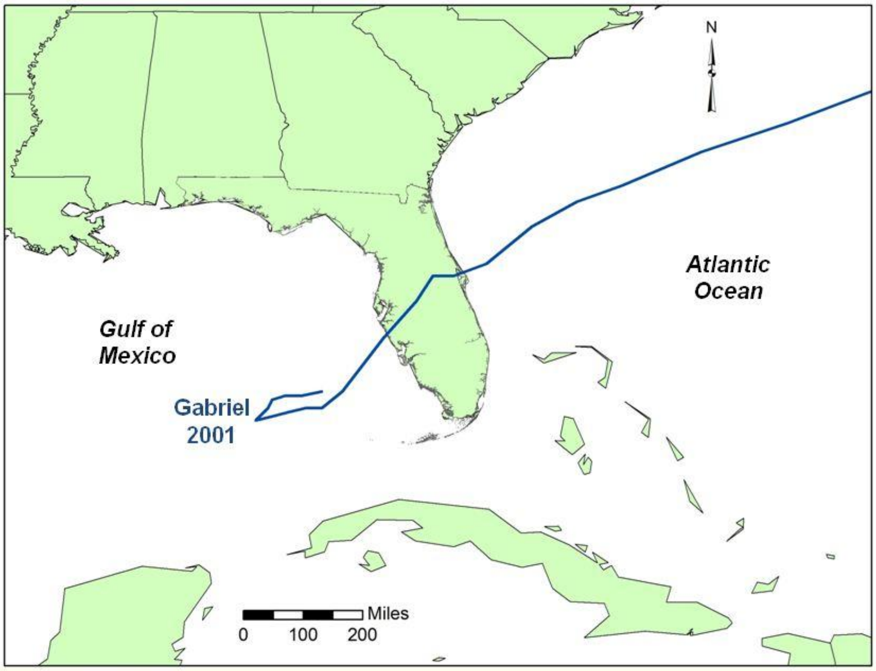

Figure 1: Hurricane Gabrielle track, September 2001

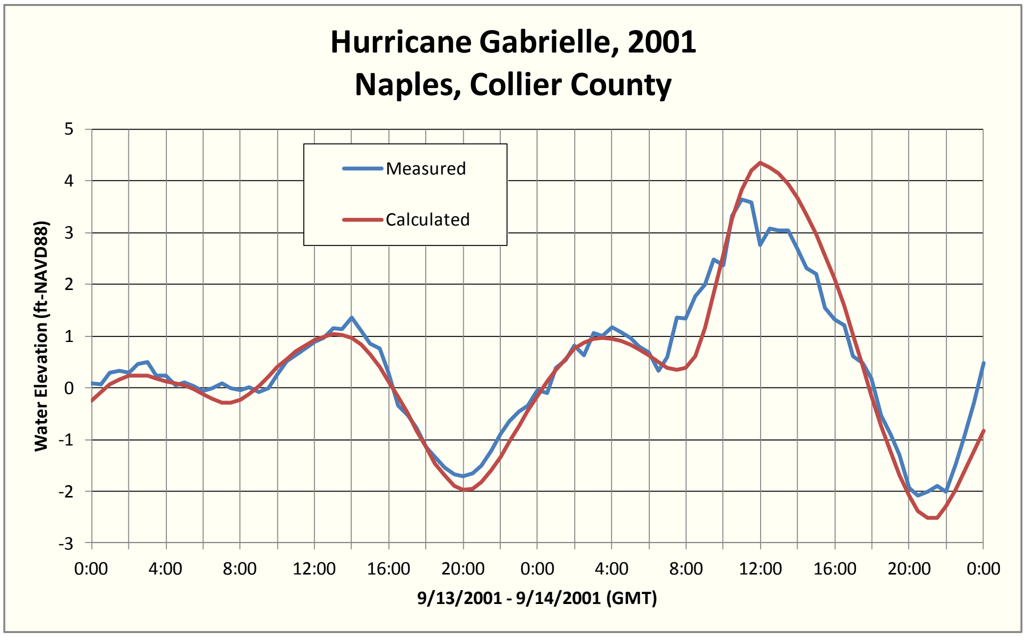

Figure 2: Comparison between measured and calculated storm tides in Naples

comparison between model calculated and measured storm tides in Naples. The model calculated storm tide is about 0.5 foot higher than the measured one, due to the fact that the tide gage is located about 350 feet offshore, where only partial wave setup is recorded during Gabrielle while the 2-D Storm Surge Model generated a storm tide with full wave setup. The 2-D Storm Surge Model demonstrated its accuracy in post-storm tide calculations, therefore the 2-D grid systems and associated hydrological data of Sarasota County from the CCCL study were used to generate storm tide data from Hurricane Gabrielle for Sarasota County. Hurricane track, pressure deficit, and radius to the maximum wind of Gabrielle were input to the 2-D Storm Surge Model. The model then ran and calculated the total storm tide, i.e. surge from barometric pressure deficit and wind stress plus wave dynamic setup and astronomical tide, for a total of 7 locations along the study area. Figure 3 displays the result of model calculated and measured total storm tides.

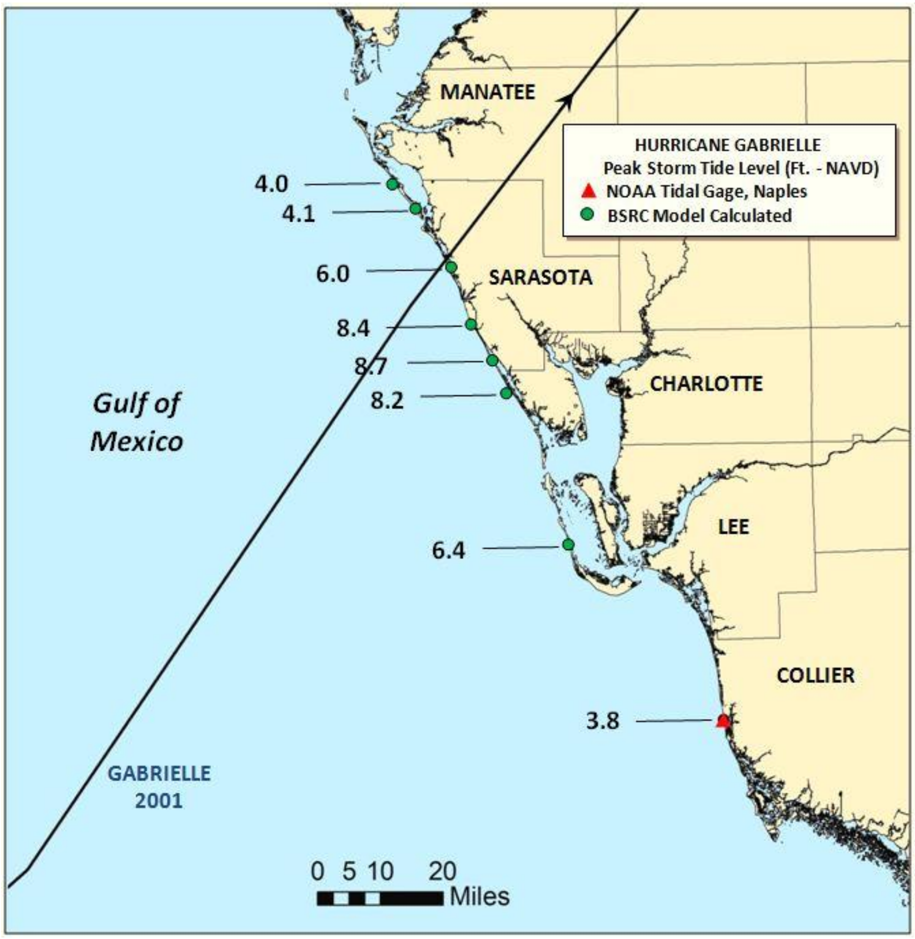

Figure 3: Peak storm tide level along the shoreline for Hurricane Gabrielle

2.1.b Wind and Wave Data

No wave data was recorded in the study area during Hurricane Gabrielle in 2001. WIS stations 73277 and 73279 which are 10 miles offshore of Venice, only provided hindcast wave data from 1980 to 1999. West Florida Central buoy 42022 and NDBC buoy 42099 did not begin to record wave data until 2004 and 2007, respectively. However, since the wind speed and direction data were available from the National Hurricane Center (Lawrence and Blake, 2002), the significant deep wave height, H_s, and dominant period, T_p can be estimated by empirical equations as shown in the following:

$$H_s = \frac{U_{max}^2}{36g}$$

$$T_p = \frac{2U_{max}}{g}$$

where U_{max} is the maximum wind speed in m/s. These equations were developed and verified by Maynord et al (2011) and its calculated results were very close to the buoy data for Hurricanes Lili of 2002, Claudette of 2003, Ivan of 2004, Katrina and Rita of 2005. Figure 4 shows the resulting deep water wave data by applying the measured wind speed to these equations for Hurricane Gabrielle in 2001.

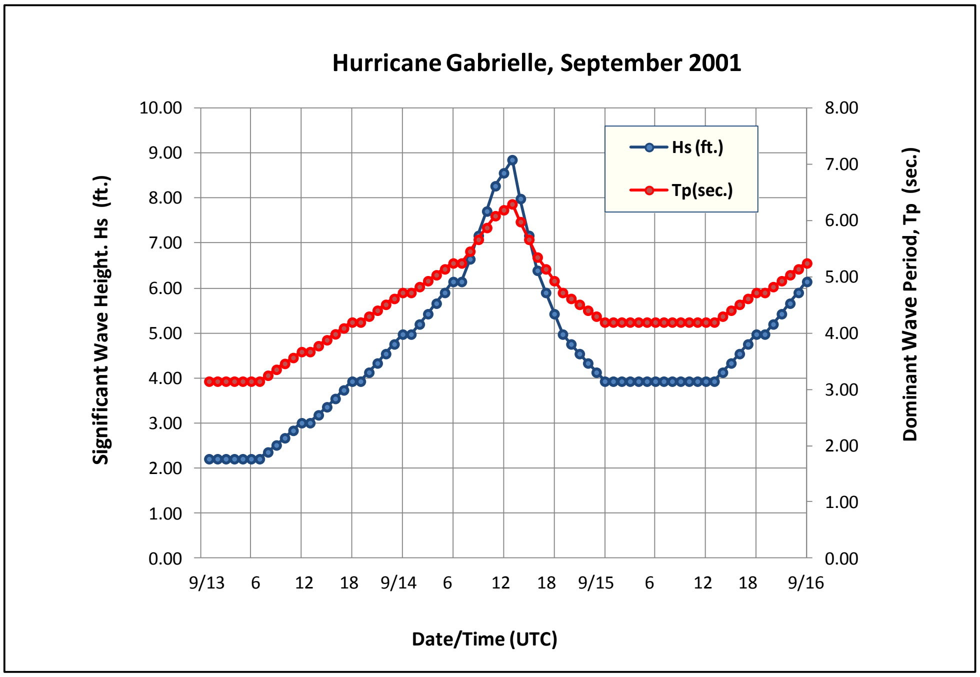

Figure 4: Best estimated variable wave conditions for Hurricane Gabrielle, 2001

2.1.c Hydrographic Survey Data

There was no beach profile specifically surveyed for the purpose of Hurricane Gabrielle in Sarasota County. However, some beach profile surveys were available through the FDEP website (Reference 4) due to beach nourishment projects in the Venice area. The two phases of Venice Beach nourishment projects started in August 1994 and ended in May 1996. A total of 1.8 million cubic yards of sand were put on the 3.3 miles of beach from R-116 to R-133. Annual beach profile surveys after nourishment were performed for project monitoring purposes. Beach profiles surveyed in June 2001 and May 2002 from R-121 to R-133 were selected initially as pre-storm and post-storm profiles for model calibration, respectively. The June 2001 beach profiles were surveyed 6 years post beach nourishment when it had reached a stable state, which is clearly shown in the shoreline and volume changes plots at the BSRC website (Reference 2).

The May 2002 beach profiles were surveyed 7 months after Hurricane Gabrielle made impact on the Venice Bach area in September 2001. A total of 9 profiles, R-121, R-123A, R-124, R-125, T127, R-129, R-130, R-132, and R-133, all of which showed consistent erosions were used in model calibrations. The map in Figure 5 shows the location of the profiles selected for the SBEACH model calibration and the storm tides calculated with the 2-D storm surge model are also indicated relative to the profile locations.

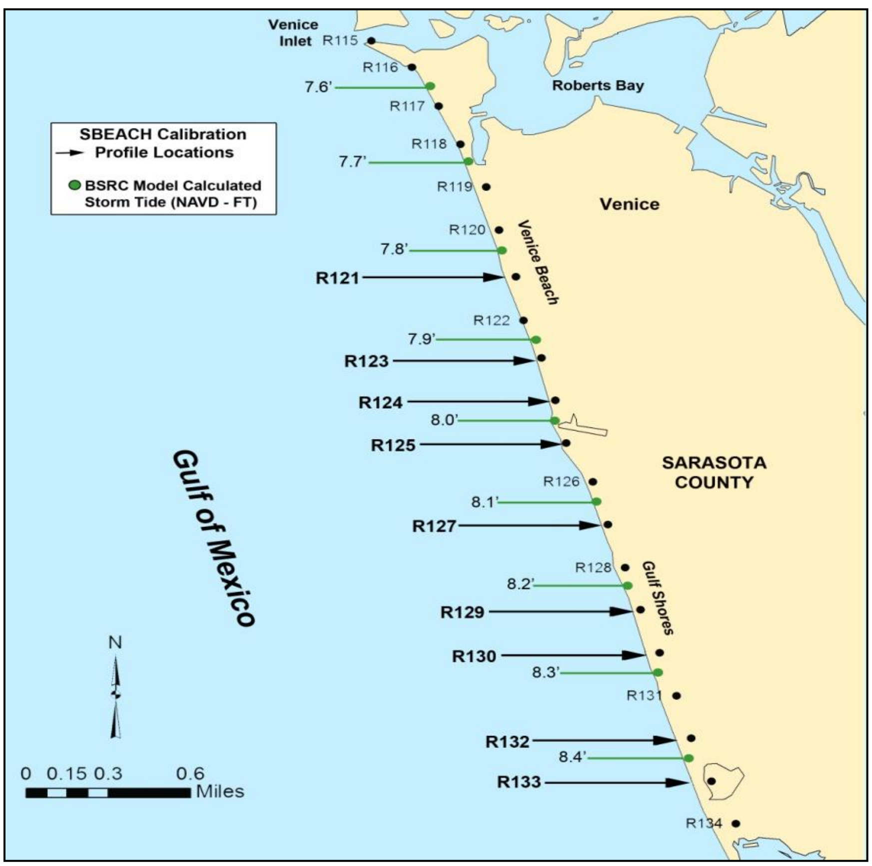

Figure 5: Locations of profiles and storm tides used in SBEACH calibration

2.2 Model Input Parameters

The SBEACH model's primary input includes profile, storm and sediment data. Profile data are prepared according to its locations on a "reach" of shoreline. Median grain size of the beach material is one of the primary sediment data required. Other input includes model parameters such as grid size, time step, and the transport rate coefficient.

The beach profiles, called a reach in the SBEACH model, were represented in the model using a constant grid scheme with grid cell spacing of 5 feet in order to generate a detailed result. Each reach was approximately 3,400 feet long and had about 680 cells of 5 feet across, well below the 1,000 cell limit allowed by the SBEACH model. Sediment data was obtained from the beach nourishment project in the Venice area (Reference 2). Beach surface and beach core boring sampled for the beach nourishment project in 1994 showed the average mean grain size was about 0.35mm.

The average eroded beach slope measured from the 9 selected May 2002 (post-storm) surveyed profiles was found to be mild, with a range from 7 to 11 degrees. The maximum slope prior to avalanching is the maximum slope angle, ranging from 15 to 90 degrees, that the profiles is allowed to achieve. Different angles were tested during the calibration and erosion results were not sensitive to this parameter. It was due to the fact that SBEACH calculated erosion slopes did not reach the minimum angle of 15 degrees for any of the post-storm survey profiles. Other parameters tested in the model calibration were the land ward surf zone depth, water temperature, and the transport decay factor. The default values are shown in Table 2.

Table 2 Listing of SBEACH Input Parameters

Parameters	**Unit**	**Default Value**	**Range of Recommended Values**
Transport rate coefficient, *K*	m^4 /N	1.75 e^{-006}	0.25 e^{-006} - 2.5 e^{-006}
Overwash transport parameter		0.005	0.002 - 0.008
Coefficient for slope dependent term, ε	m^2/s	0.002	0.001 - 0.005
Transport rate decay coeff. multiplier, λ	m^{-1}	0.5	0.1 - 0.5
Landward surf zone depth	ft.	1.0	0.5 - 1.6
Effective grain size (mean D_{50})	mm	0.35	0.15 – 1.0
Maximum slope prior to avalanching	degree	45	15 - 90 deg.
Water temperature	degree, C	20	0 - 40

2.3 Model Calibration Results

The sensitivity evaluation resulted in initially setting most of the model input parameters at or near the default values as described above. Wind speed and direction, available as options during the model input were not included due to its insignificant effect in the model results. For each SBEACH run, only the hydrographs without wave setup were entered since the SBEACH model calculated and added the wave setup internally to reach the desired final water level. It was noted the maximum water elevation values from SBEACH output at each of the calibration profiles showed significantly lower peak storm tide elevations than values generated by the 2-D storm surge model (Leadon and Nguyen, 2010). Therefore, the hydrographs input from the initial calibration work were adjusted a sufficient amount, so the peak water elevation output from SBEACH were very similar to the peak storm tide values from Hurricane Gabrielle.

For the purpose of area wide application of the SBEACH model in Sarasota County, the 9 selected profiles represented the most windward area being impacted by Hurricane Gabrielle. The storm tide levels from 7.8 feet to 8.4 feet calculated for the 9 profiles are equivalent to a return intervals of 30 years (BSRC, 2011), which is qualified as a high frequency storm event. The average measured versus the SBEACH calculated erosion distance for contours from 0 to 8 feet above NAVD 88 of the 9 profiles were used as the principle basis for determining the calibration parameters setting.

Since Sarasota County consists mainly of low level beaches and barrier islands, like Lido Key and Longboat Key, the overwash transport parameter was scrutinized during model calibration. The overwash algorithm in the SBEACH model was improved by the incorporation of more advanced hydrodynamics and sediment transport considerations. The model was validated at Ocean City, and at Assateague Island, MD, the former representing a location with a protective dune typical of shore protection projects and the latter location representing a low and wide barrier island in a nature condition (Larson, Wise and Kraus, 2004).

The estimated variable wave heights and periods (Figure 4) were first tested in the model calibration. For the purpose of simpler county wide application of SBEACH, a constant wave height and period will be used. Different constant wave heights and periods were later tested for a good calibration result. It was found that 7 feet wave height and 7 seconds wave period matched well with the calibration results from the estimated variable wave conditions. It is noted that even 7 seconds wave period was higher than the estimated one, any wave periods smaller than 7 seconds would generate unrealistic erosions.

Starting with the default values, a series of values for each calibration parameter were tested. It was able to determine some of the parameters were insensitive during the tests as mentioned above. The overwash parameter, the coefficient for slope dependent term, ε, and the transport rate coefficient, K, were found to be very significant to the calibration results, so they were adjusted individually until reasonable agreement with the measured erosions were achieved.

Hard bottoms (HB) in Sarasota County consist of macroalgae, sponges, stony corals. octocorals and other organisms exist near both nearshore and offshore. The algorithm developed for HB features in SBEACH (Larson and Kraus, 1998) is applicable to HB appearing on the dune, foreshore, and surf zoon, but not in the far offshore, beyond the influence of breaking waves. Available HB measurements data for Sarasota County are listed in Appendix A. A series of tests to include HB in SBEACH for the calibration profiles showed HB were so far offshore that no difference were found in the beach erosions between the profiles with and without HB.

The final parameter values were determined as those providing the best presentation of measured erosions for the 9 selected profiles. The final parameter values resulting from the model calibration are summarized in Table 3. Figure 6 shows comparisons of average contour recessions between measured and SBEACH model computed for Hurricane Gabrielle based on the final model parameters described above. Plots of pre-storm, post-storm, and SBEACH model predicted profiles with the final calibration parameters for each of the 9 profiles are presented in the Appendix B.

Table 3 Recommended SBEACH Model Parameters for Sarasota County

Parameters	**Unit**	**Recommended Values for HF Storm for Sarasota County**
Transport rate coefficient, *K*	m^4 /N	0.5 e^{-006}
Overwash transport parameter		0.002
Coefficient for slope dependent term, ε	m^2/s	0.005
Transport rate decay coeff. multiplier, λ	m^{-1}	0.5
Landward surf zone depth	ft.	1.0
Effective grain size (mean D_{50})	mm	0.35
Maximum slope prior to avalanching	degree	15
Water temperature	degree, C	28
Wave Height, H	ft.	7
Wave Period, Tp	Sec.	7
Wave Direction, α	degree	0 (shore-normal)

The 9 calibration profiles are located in the Venice area and span a distance of 2.3 miles were selected for the SBEACH model calibration for Hurricanes Gabrielle in this study. Average erosion distances above 0 foot NAVD88 at each foot contour were compared between the model predicted and measured so the best SBEACH model parameters could be achieved.

It is noted from Figure 6 and Appendix B that the model predicted average erosions for constant waves generally agreed with the variable waves. Therefore, it is reasonable to use the recommended constant waves for the SBEACH model application in the Sarasota County area. Differences of average erosions between model predicted with constant waves and pre- and post-storm measured were within 7 feet at all contours. Therefore, the SBEACH model predicted erosions with the calibrated parameters (Table 3) came to close agreement with the measured ones for most profiles, especially for R-124 and R-125.

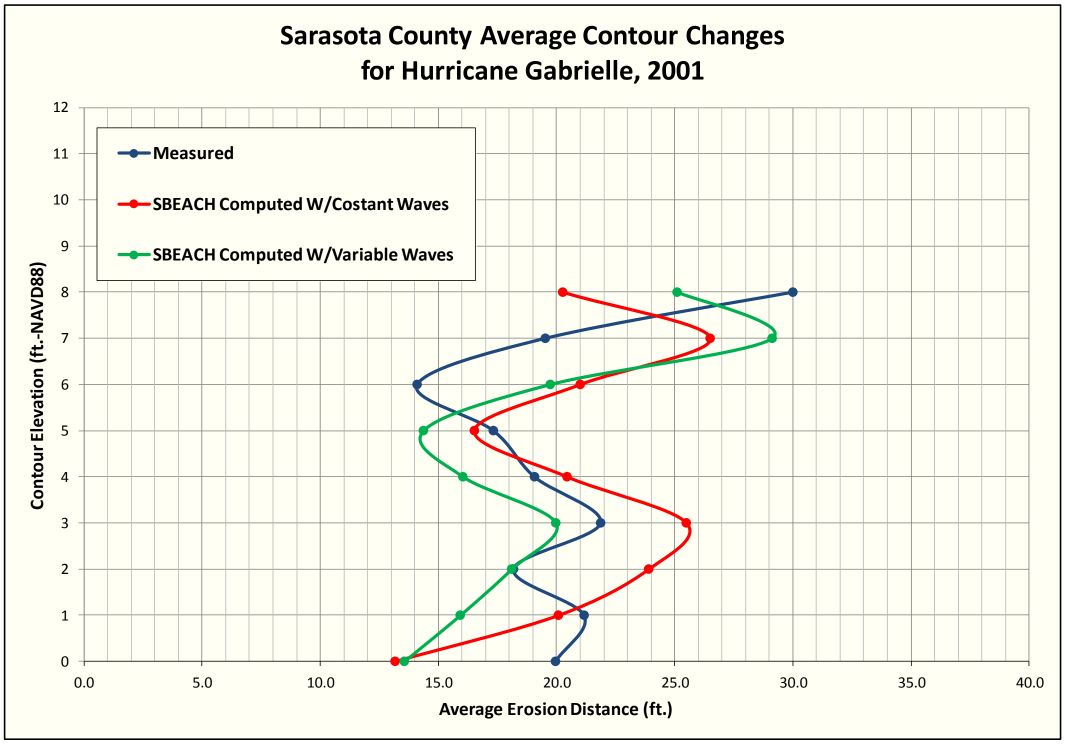

Figure 6: Comparisons of average contour recessions between measured and SBEACH model computed for Hurricanes Gabrielle

3. Sarasota County SBEACH Application

3.1 Model Configuration

Application of SBEACH model in Sarasota County for high-frequency storm erosion was based on the model calibration results, as shown in Table 3 of the previous section. Sediment data were obtained from beach nourishment projects for Longboat Key, Lido and Venice from 1994 to 1998 (Reference 2), and from the sediment distribution analysis for every nine ranges in Sarasota County by Jones (1994). Figure 7 summarizes these sediment data and an average mean grain size of 0.35 mm was considered the best fit for county wide model applications.

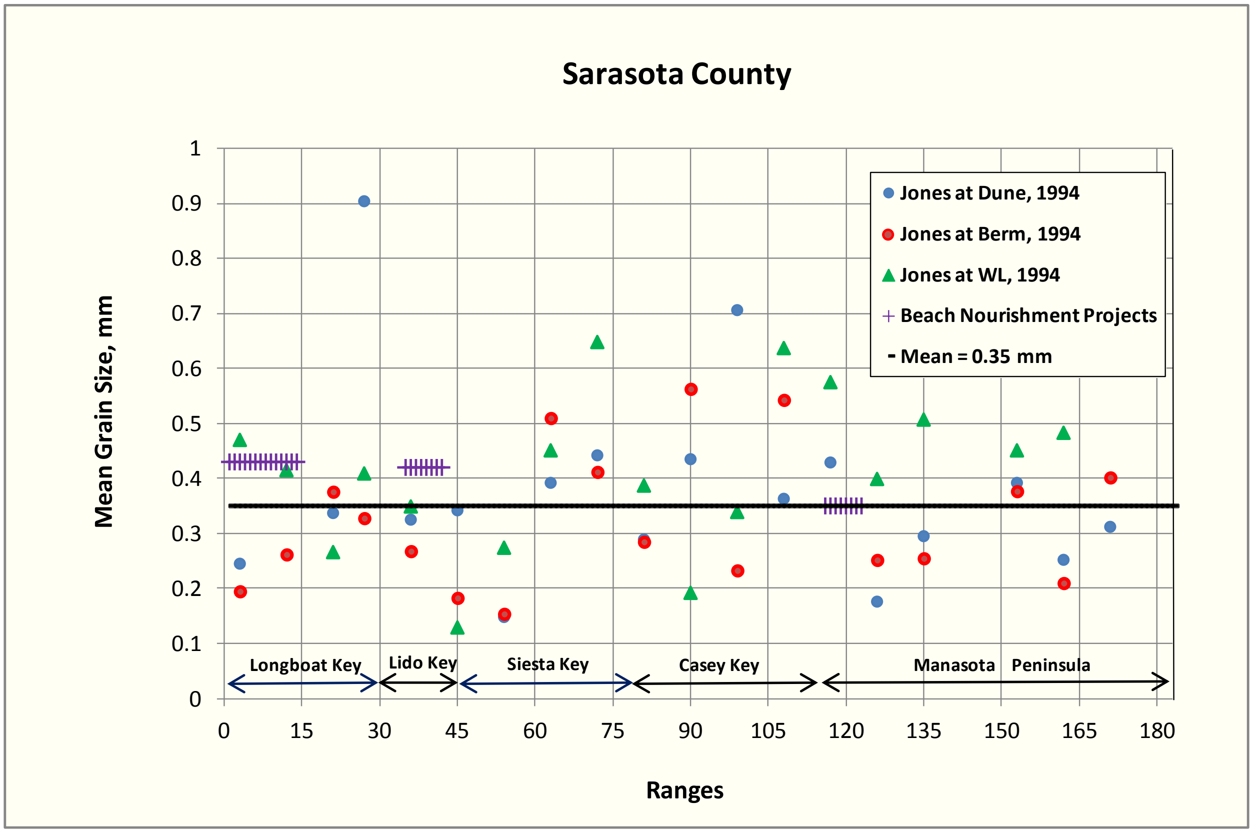

Figure 7: Sediment data distributions in Sarasota County

Sarasota County storm tides and hydrographs developed by BSRC (2011) for 15- and 25-year storms are shown in Table 4 and Figure 8.

Table 4 High-Frequency Storm Tides for Sarasota County

Return Period, TR (years)	Storm Tide Level* (ft.- NAVD)		
	North Profile (R-1 to R-44)	Middle Profile (R-45 to R-135)	South Profile (R-136 to R-183)
25	7.5	7.4	7.2
15	6.4	6.2	6.0

*Includes contributions of: wind stress, barometric pressure, dynamic wave set-up and astronomical tide.

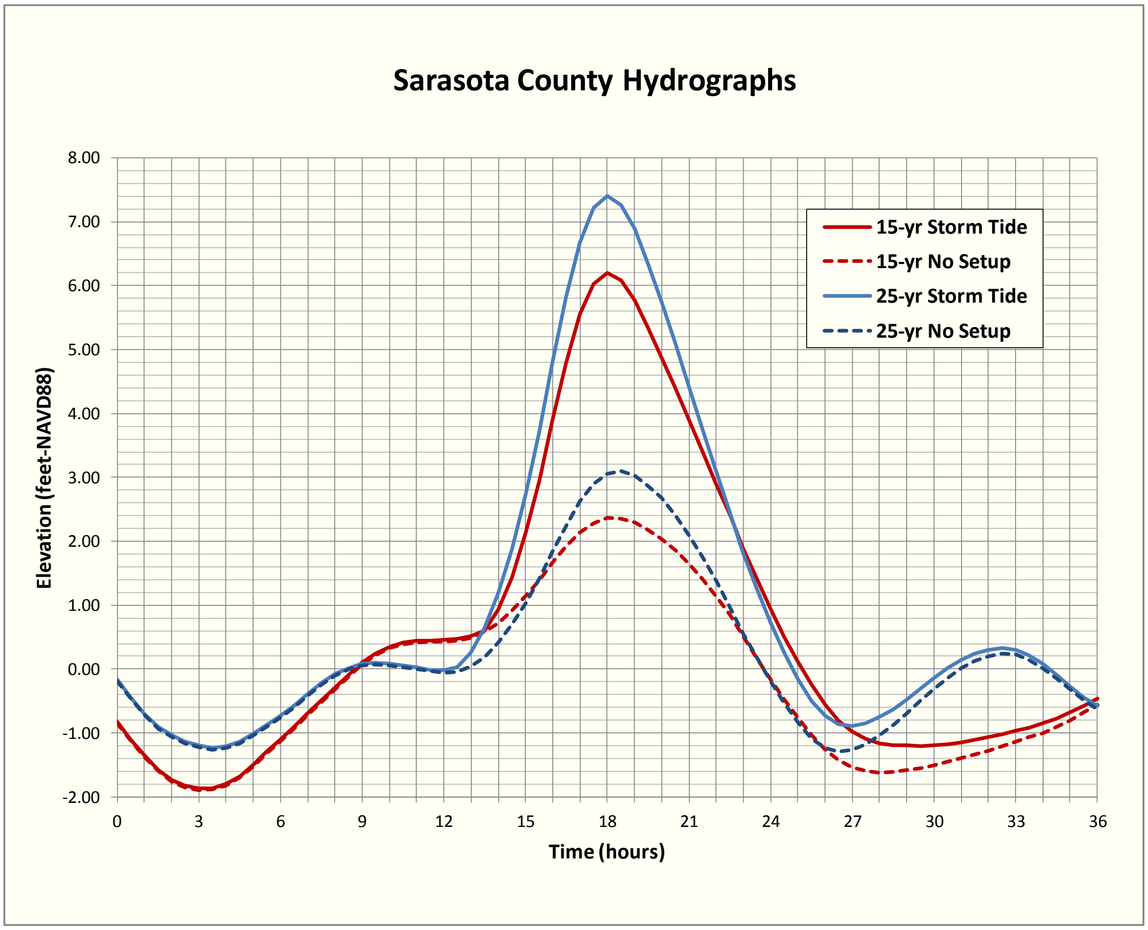

Figure 8: Hydrographs of 15- and 25-year for Sarasota County

As mentioned in the Model Calibration Results (Section 2.3), only the hydrographs without wave setup were applied since the SBEACH model calculated and added the wave setup internally to reach the final water level. If the final model output water level did not agree with the desired 15- or 25-year storm tides, the input hydrographs were then adjusted so the resultant SBEACH model peak water levels were equivalent to the predicated storm tides for each profile. Recommended Reach and Storm input values to be used in 15- and 25-year storm erosion calculations by SBEACH are listed in Appendix C. Time series values for the original and adjusted hydrographs are shown in Figures 9 and 10 and are tabulated in Appendix D.

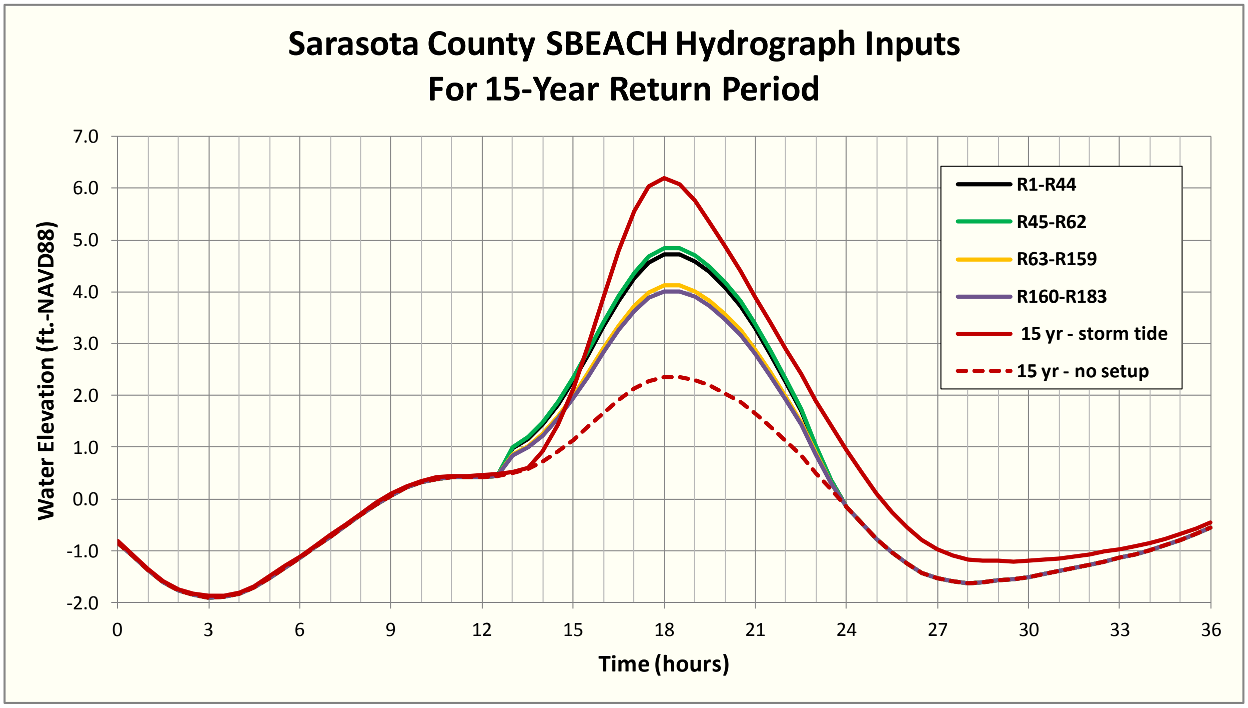

Figure 9: 15-year hydrographs for Sarasota County profiles in SBEACH application

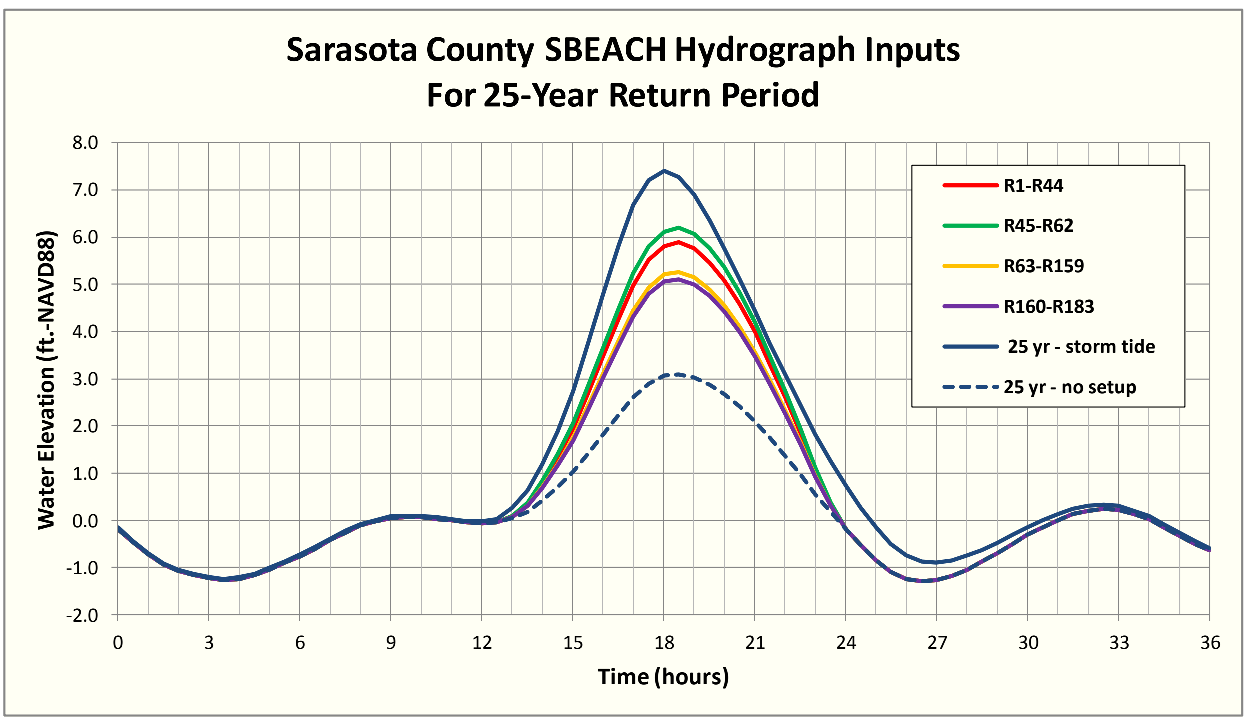

Figure 10: 25-year hydrographs for Sarasota County profiles in SBEACH application

3.2 Model Application and Results

Tables showing the horizontal eroded distances between the initial profile and the eroded profiles for specific elevation interval for 15- and 25-year storms are listed in Appendix E. Plots of the initial profile and the associated eroded profiles generated from SBEACH for the 15- and 25-year return periods for 181 of 183 range location profiles of Sarasota County are provided in Appendix F. R-30 and R-45 are located by inlets were not included since the profiles were surveyed across the inlet and SBEACH could not produce reasonable eroded profiles. In addition to the regular runs with sandy beach profiles, some profiles with rock armor revetments, like R-64, R-65, and R-66 were tested with a default value of scour attenuation coefficient. The results from these profiles were not included in this study, since there is no calibration data available for profiles with sea wall and revetment at present time. The survey profiles used as the input profiles in SBEACH are listed in Table 5.

Table 5 Profiles Used in SBEACH Application for Sarasota County

Ranges	**Beach Profiles Survey Dates**	**Offshore Profiles Survey Dates**
1-29	Nov. 2011	Nov. 2011
30	Sept. 1993, Aug. 2005	Sept. 2001
31-44	July 2012	July 2012
45-46	Dec. 2001	Dec. 2001
47	May 2009	Aug. 2005
48	Aug. 2005	Aug. 2005
49-61	May 2009	Aug. 2005
61A	Aug. 2005	Aug. 2005
62-63	May 2009	Aug. 2005
64-83	Aug. 2010	Aug. 2010
84-108	May 2009	May 2009
109	May 2009	Aug. 2005
110-114	May 2009	May 2009
115-136	Aug. 2011	Aug. 2011
137-157	May/June 2009	May/June 2009
158	June 2009	Aug. 2005
159-163	June 2009	June 2009
164	June 2009	Sept. 2005
165-166	June 2009	June 2009
167	June 2009	Aug. 2005
168-183	June 2009	June 2009

The plots in Appendix F are shown in the NAVD88 vertical datum. The map in Figure 11 below depicts the FDEP profile range locations along the Sarasota County shoreline.

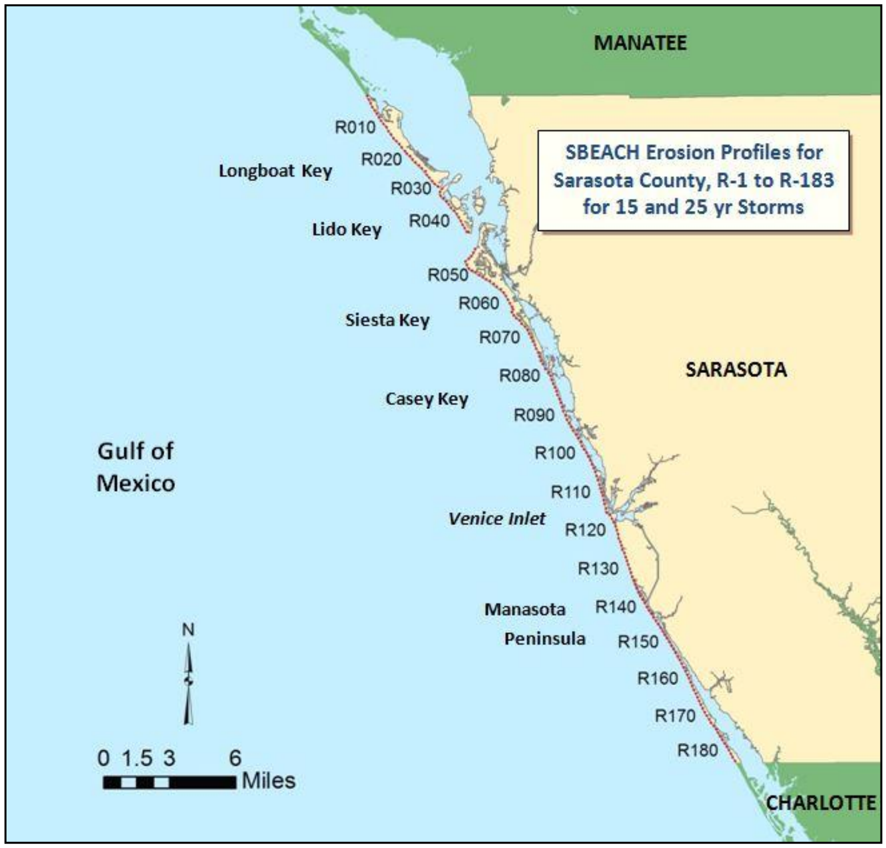

Figure 11: FDEP profile range locations along the Sarasota County shoreline

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APPENDIX A

Hard Bottom Measurement data for Sarasota County

Sarasota County Hard Bottom Offshore Distance (ft.) from Monuments

Range	Start	End	Start	End	Date	Resource
13	240	270	1380	1440	10/2002	CPE (2011)
14	300	390			10/2002	CPE (2011)
66	210	600			2004 - 2006	CPE (2006)
82	870	1470			2004 - 2006	CPE (2006)
83	760	1500			2004 - 2006	CPE (2006)
85	870	1670			2005	FDEP Aerials
86	1300	2100			2005	FDEP Aerials
87	1300	2100			2005	FDEP Aerials
88	1130	1930			2005	FDEP Aerials
89	825	1625			2005	FDEP Aerials
90	480	520	1000	1800	2005	FDEP Aerials
91	1040	1840			2005	FDEP Aerials
92	825	1625			2005	FDEP Aerials
93	825	1625			2005	FDEP Aerials
94	910	1710			2005	FDEP Aerials
125	100	150			2/2003	Coastal Tech (2003)
126	1400	2100			2/2003	Coastal Tech (2003)
127	700	1450			2/2003	Coastal Tech (2003)
128	1100	1550			2/2003	Coastal Tech (2003)
129a	950	1050	1400	1950	2/2003	Coastal Tech (2003)
130	900	1200	1700	1900	2/2003	Coastal Tech (2003)
131	900	1300			2/2003	Coastal Tech (2003)
132	700	1300			2/2003	Coastal Tech (2003)
133	700	1110	1600	1800	2/2003	Coastal Tech (2003)
118	2200	2500			1/2011	CSA (2011)
118a	1800	2560			1/2011	CSA (2011)
119	1980	2240			1/2011	CSA (2011)
119a	1600	2050			1/2011	CSA (2011)
120	700	1150	1660	1920	1/2011	CSA (2011)
120	2750	3140			1/2011	CSA (2011)
120a	1600	1730	2240	2950	1/2011	CSA (2011)
121	1150	1730	2500	2820	1/2011	CSA (2011)
121a	1280	1920	2570	2780	1/2011	CSA (2011)
122	960	1670	2370	2560	1/2011	CSA (2011)
122a	640	1600	1920	2430	1/2011	CSA (2011)
123a	700	1600	1990	2370	1/2011	CSA (2011)
123b	960	1090	1790	2300	1/2011	CSA (2011)
124	830	1800			1/2011	CSA (2011)
126	1470	2180			1/2011	CSA (2011)
127	580	1540			1/2011	CSA (2011)
128	770	1600			1/2011	CSA (2011)
129	700	930	1400	2000	1/2011	CSA (2011)

130	770	1380	1700	2000	1/2011	CSA (2011)
131	1000	1380			1/2011	CSA (2011)
132	700	1470			1/2011	CSA (2011)
133	640	1220	1540	1860	1/2011	CSA (2011)
134	1090	1990			1/2011	CSA (2011)
135	960	1790			1/2011	CSA (2011)
136	890	1538			1/2011	CSA (2011)
137	640	1920			1/2011	CSA (2011)
138	640	1600			1/2011	CSA (2011)

Resources:

Coastal Tech, "Plane View - Fill Area, R-125 to R-133, City of Venice Federal Beach Maintenance Project, Shore Protection Project, Sarasota County, Florida", February 2003.

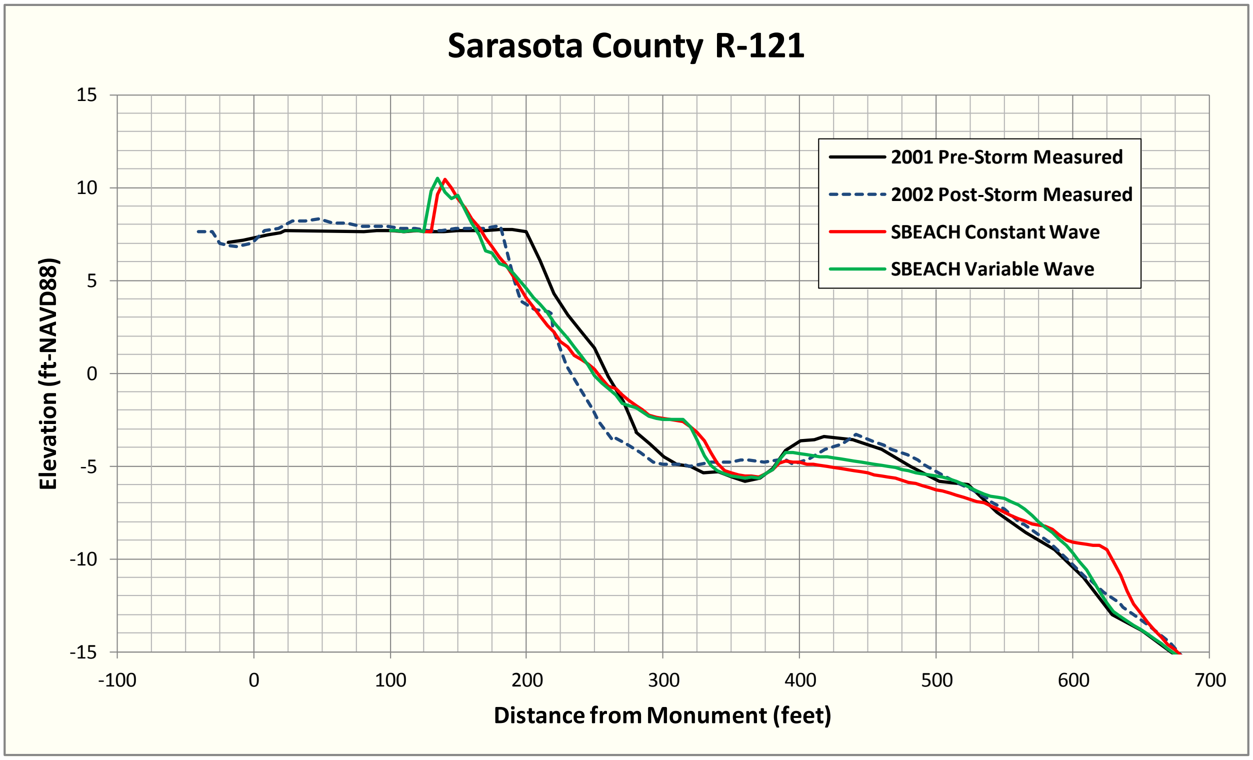
CPE, "South Siesta Key Beach Restoration Project, Nearshore Transects, R-64 to R-83", October 2006.

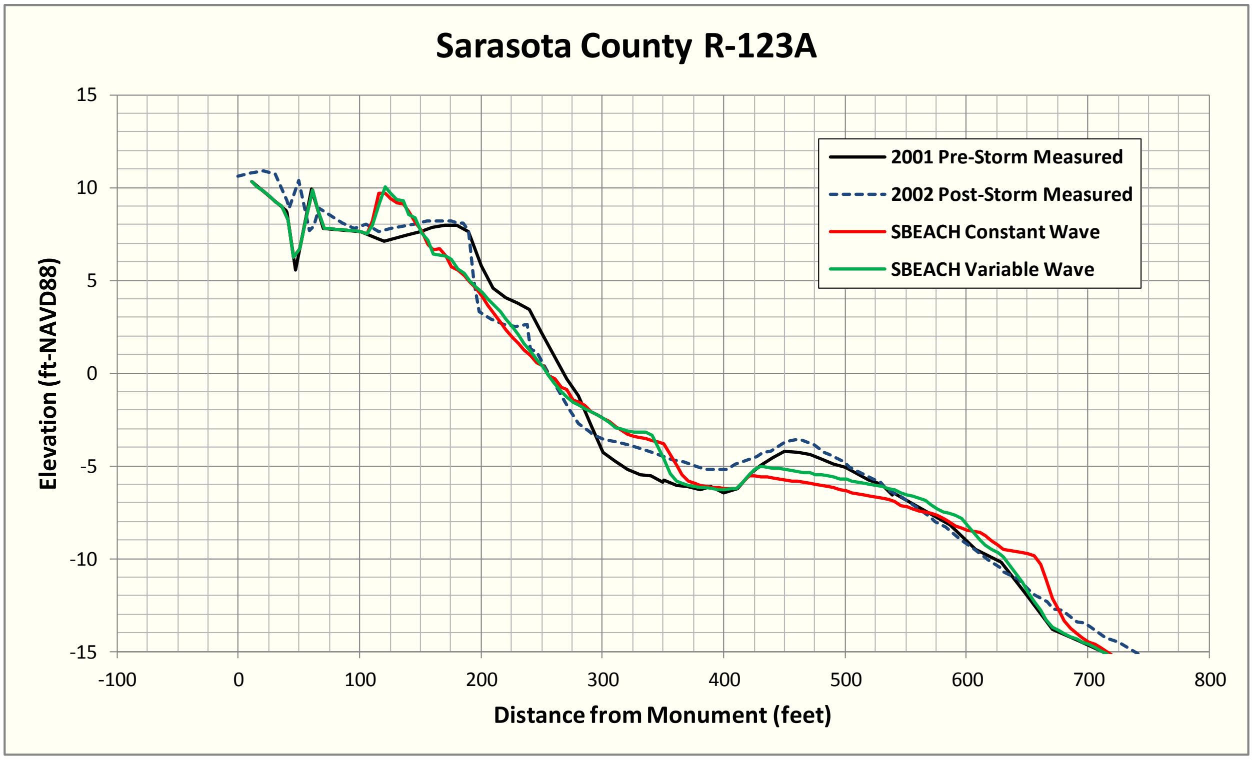
CPE, "2011/2012 Longboat Key beach Nourishment Project, Plan View R-12 to R-17", January, 2011

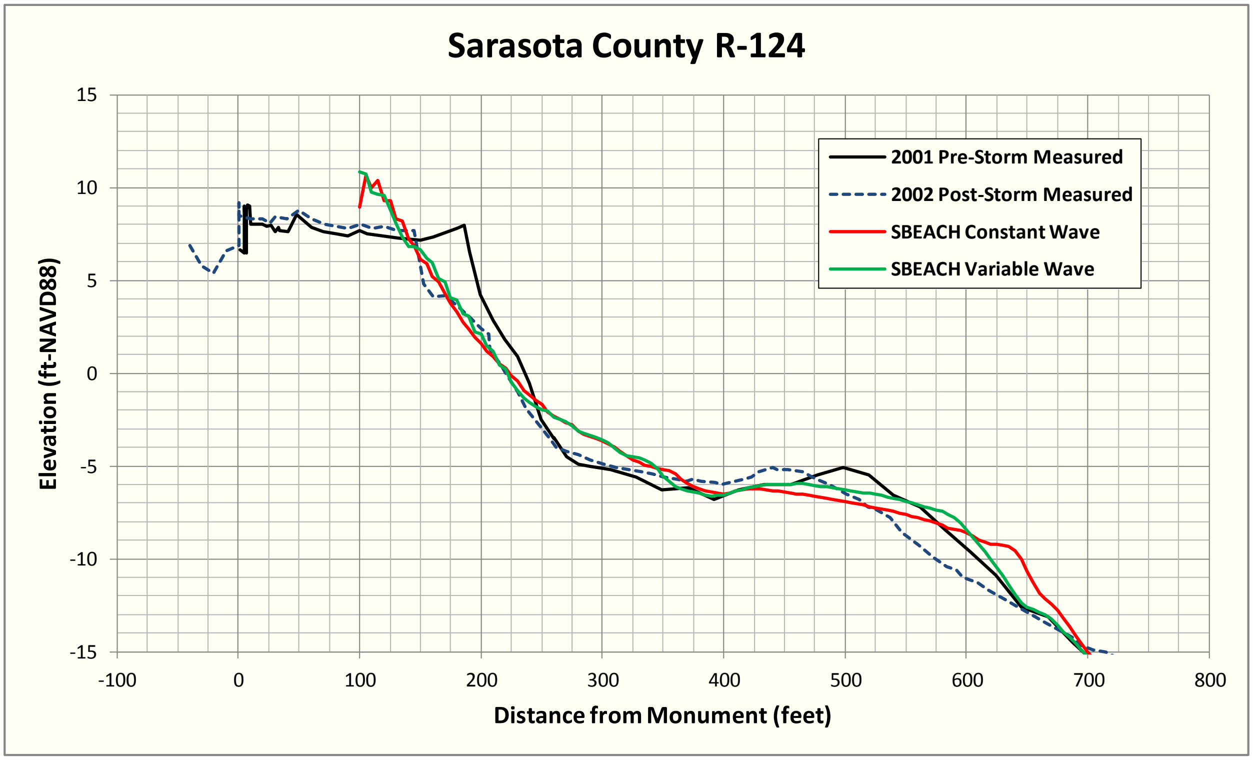
CSA International Inc., "City of Venice Beach Nourishment Project Year-5 Post Construction Monitoring Report", Prepared for Coastal Technology Corp., January 2011.

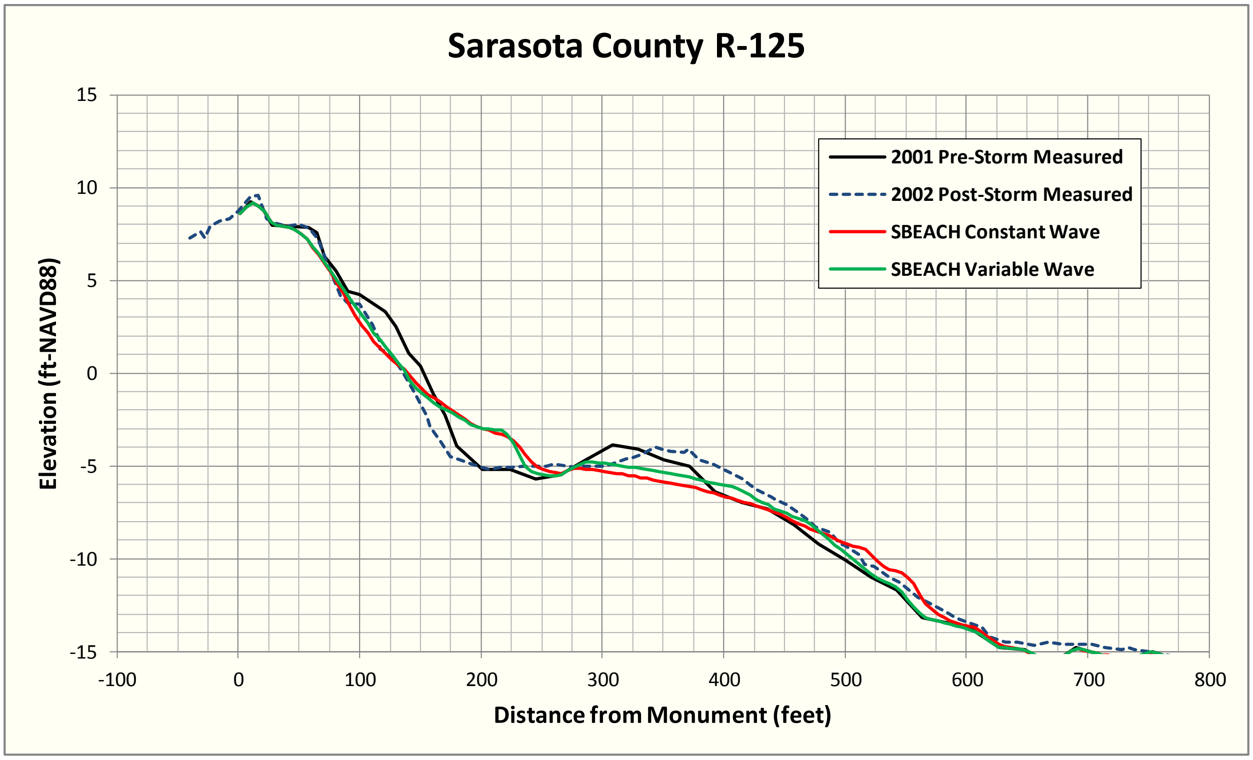
APPENDIX B

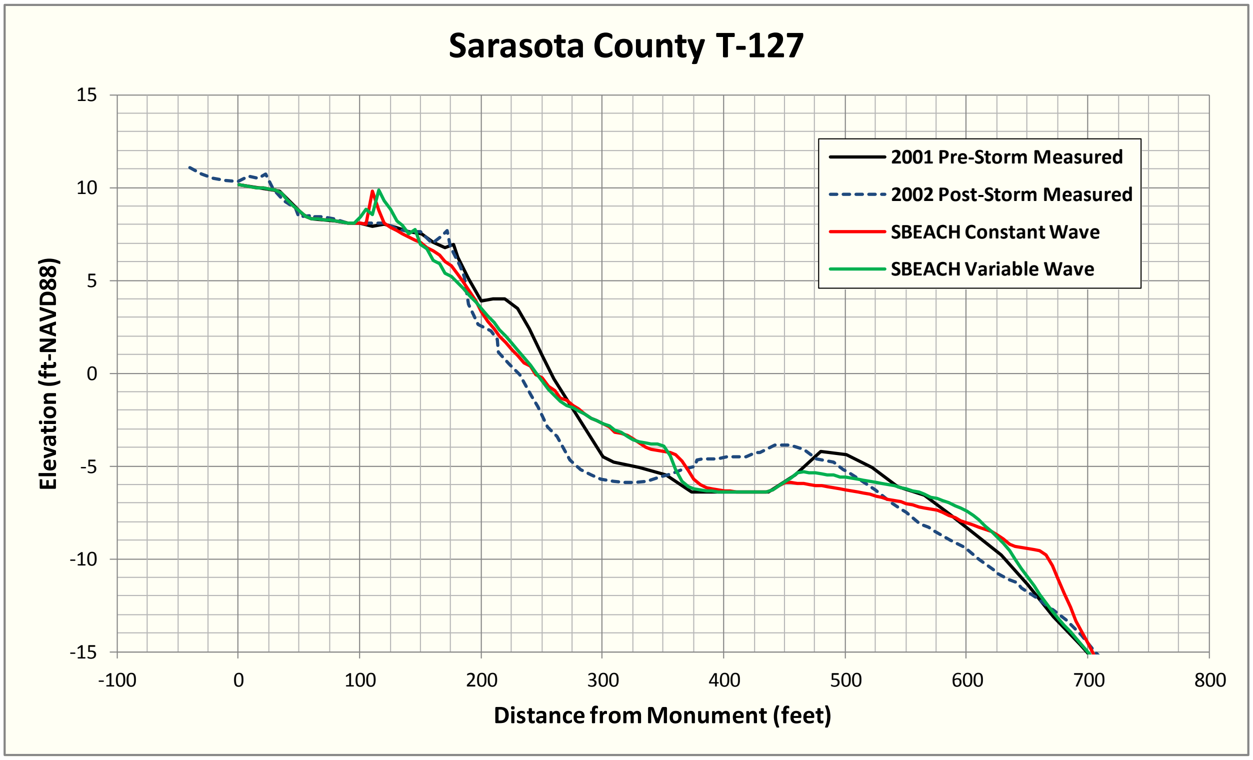
SBEACH Calibration Profiles for Sarasota County

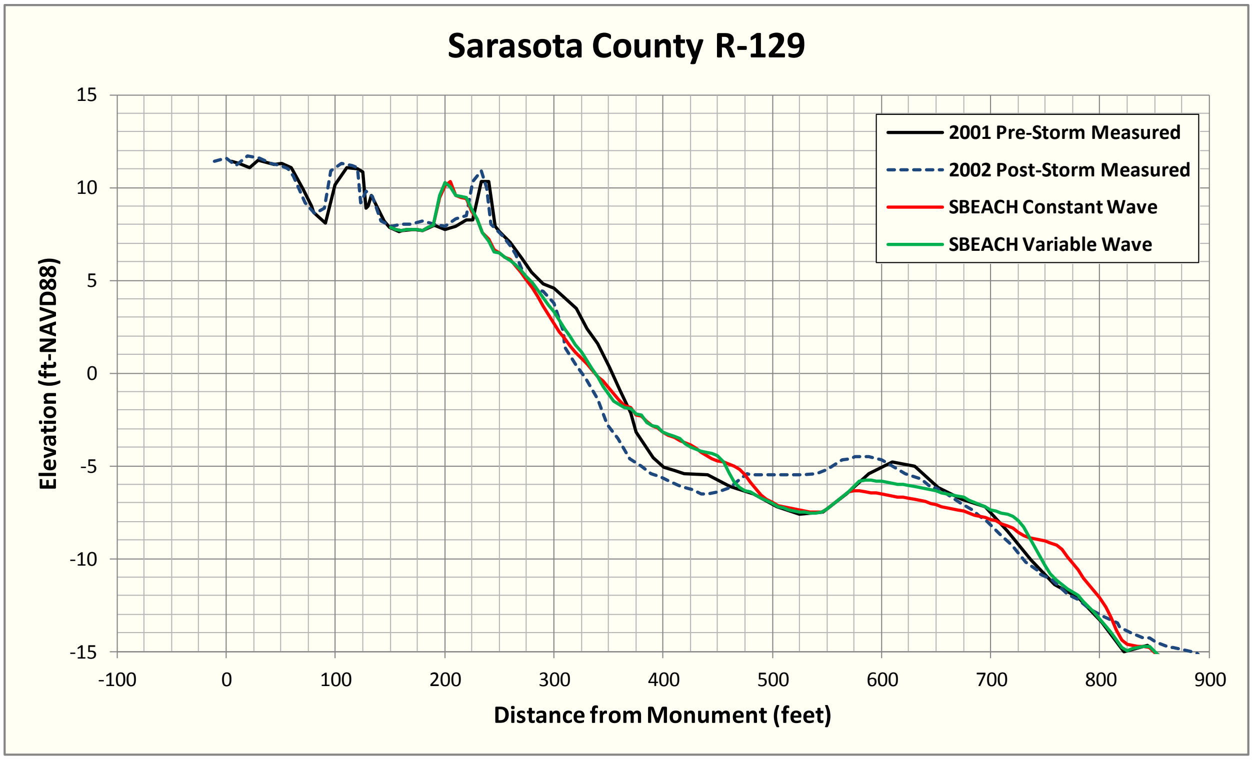

Sarasota County R-121
Elevation (ft-NAVD88)
Distance from Monument (feet)
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700

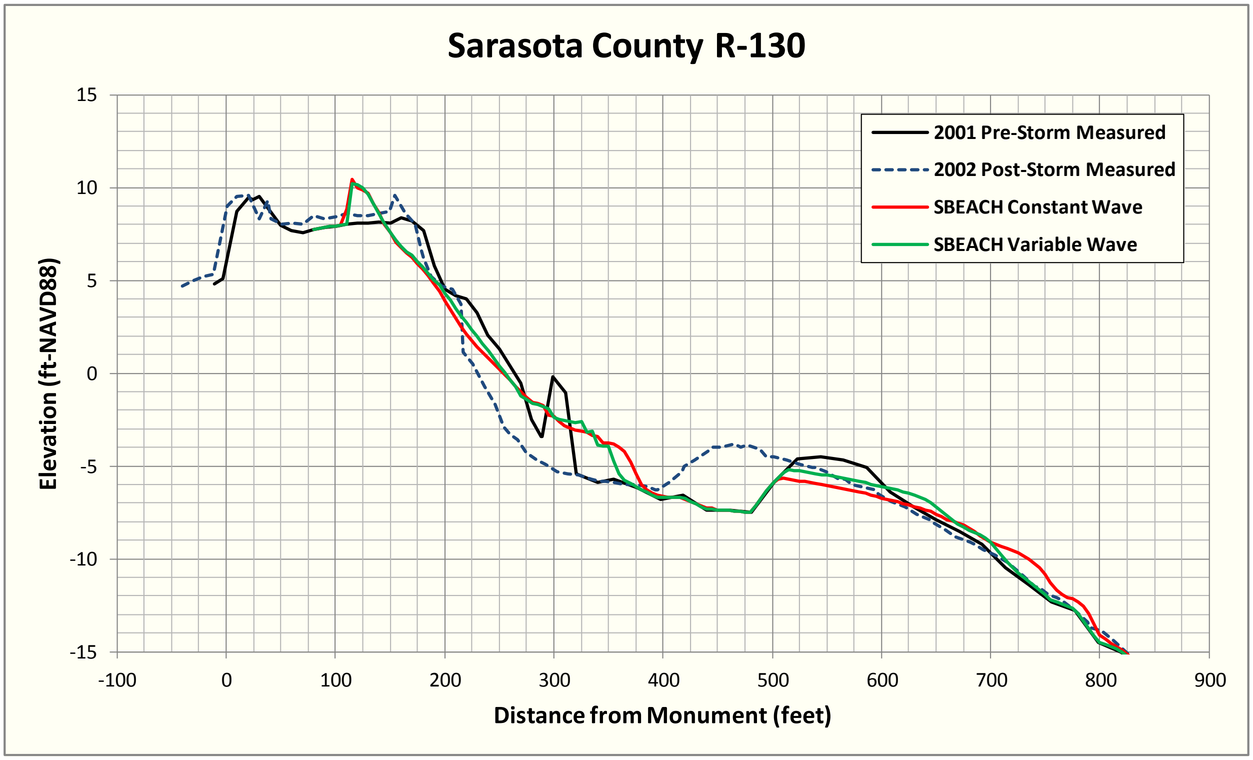

Sarasota County R-123A
Elevation (ft-NAVD88)
Distance from Monument (feet)
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700
800


Sarasota County R-124
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
Elevation (ft-NAVD88)
Distance from Monument (feet)
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700
800

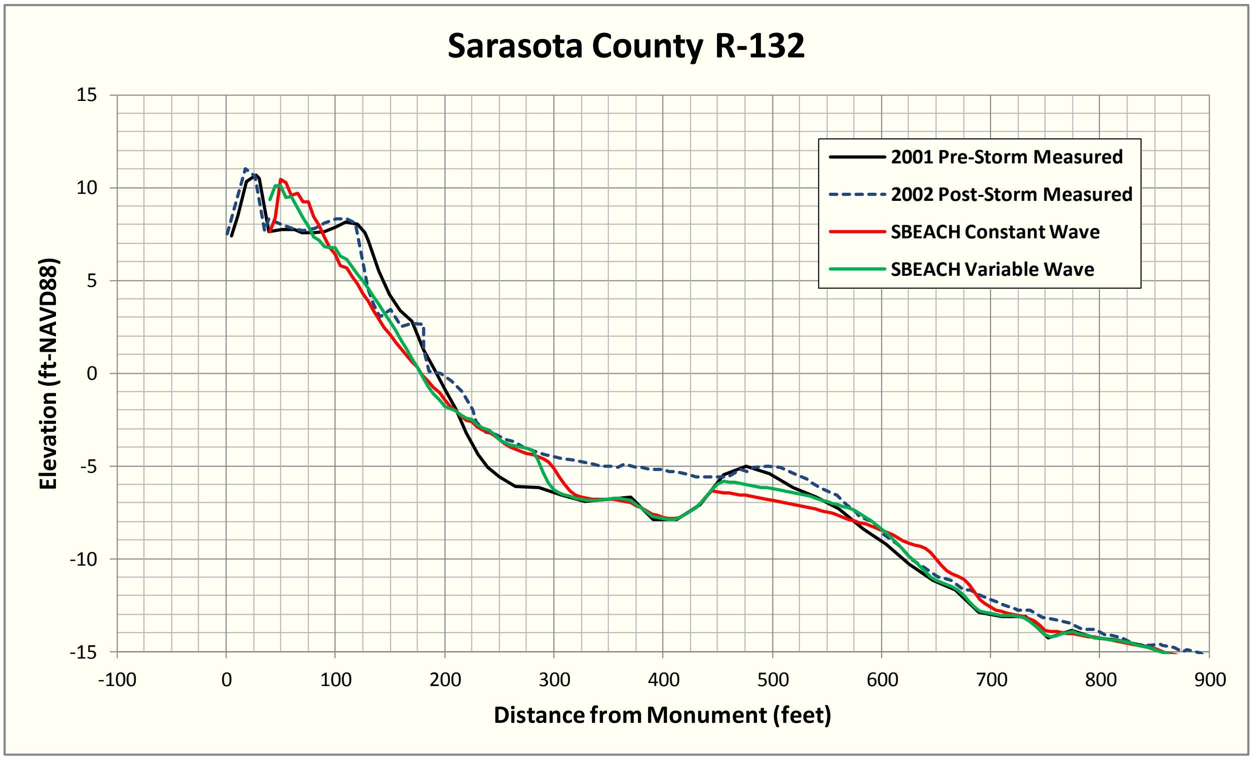

Sarasota County R-125
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
Elevation (ft-NAVD88)
Distance from Monument (feet)
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700
800


Sarasota County T-127
Elevation (ft-NAVD88)
Distance from Monument (feet)
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700
800

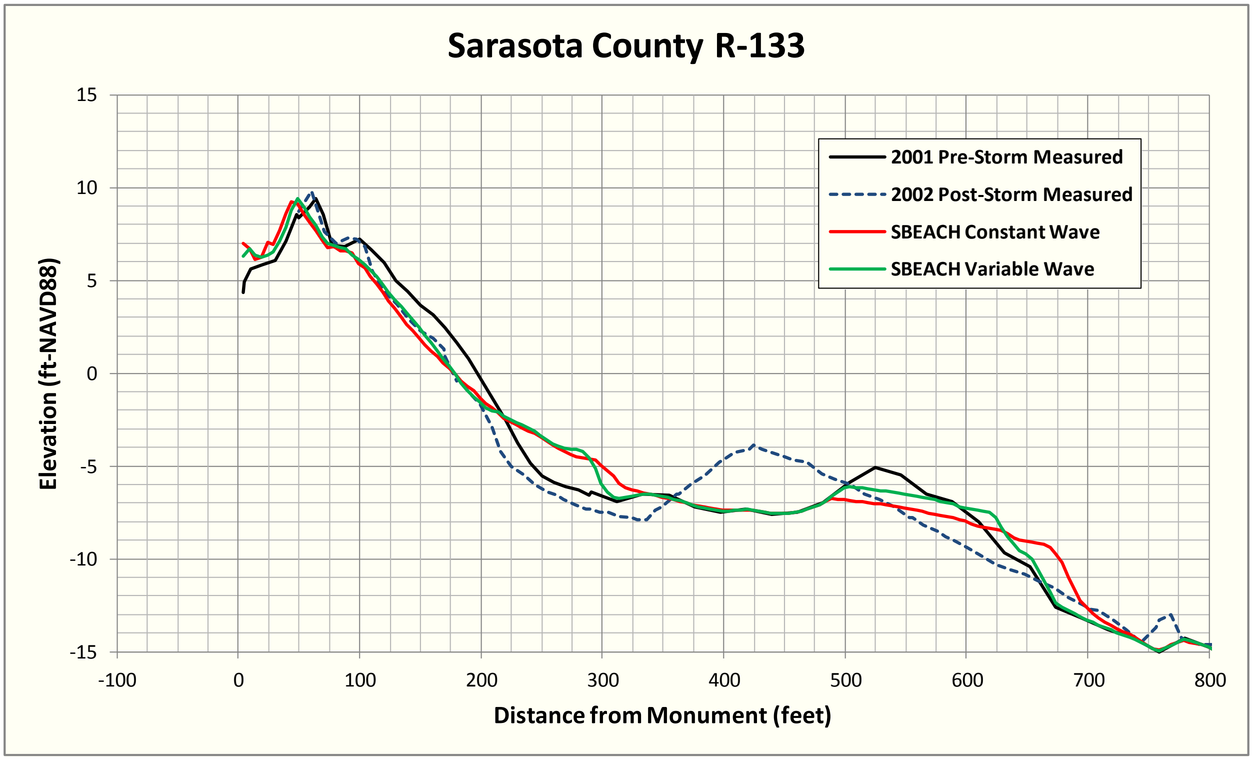

Sarasota County R-129
Elevation (ft-NAVD88)
Distance from Monument (feet)
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700
800
900



Sarasota County R-130
Elevation (ft-NAVD88)
Distance from Monument (feet)
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700
800
900



Sarasota County R-132
Elevation (ft-NAVD88)
Distance from Monument (feet)
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700
800
900



Sarasota County R-133
2001 Pre-Storm Measured
2002 Post-Storm Measured
SBEACH Constant Wave
SBEACH Variable Wave
Elevation (ft-NAVD88)
15
10
5
0
-5
-10
-15
-100
0
100
200
300
400
500
600
700
800
Distance from Monument (feet)

APPENDIX C

Recommended SBEACH Input Values

Final SBEACH Input Settings – for 15- and 25-year storm erosions in Sarasota County.

For all Storm Tide Hydrographs - Use BSRC-generated 15- and 25-year hydrographs without wave setup adjusted proportionally to peak elevation shown for each range location segment shown below; storm duration for all cases is 36 hrs. All elevations listed below are in NAVD88 vertical datum. All wave input depth values were set as deep water with no wave randomization. All storm time steps were set at 5 minutes. Water temperature is set at 28 deg. Grid cell width is 5 feet.

Final SBEACH Input Values for Range Segments

Input Parameters	**R1 - R44**	**R45 - R-62**	**R63 - R159**	**R160 - R183**
Transport Rate Coefficient, *K*	0.5 e^{-006}	0.5 e^{-006}	0.5 e^{-006}	0.5 e^{-006}
Overwash Transport Parameter	0.002	0.002	0.002	0.002
Coefficient for Slope Dependent Term, ε	0.005	0.005	0.005	0.005
Transport Rate Decay Coeff. M ultiplier, λ	0.5	0.5	0.5	0.5
Landward Surf Zone Depth (ft.)	1.0	1.0	1.0	1.0
Maximum Slope Prior to Avalanching	15	15	15	15
Constant Wave Height (ft.)	7	7	7	7
Constant Wave Period (sec.)	7	7	7	7
Grain Size (mm)	0.35	0.35	0.35	0.35
Adjusted 15-year Hydrograph Peak Elevation (ft.)	4.7	4.8	4.1	4.0
Adjusted 25-year Hydrograph Peak Elevation (ft.)	5.8	6.1	5.2	5.0

APPENDIX D

Adjusted 15- and 25-year Hydrograph Tables for Sarasota County

Sarasota County - Adjusted 15-year Storm Surge Elevation Hydrograph Time Series Values for SBEACH (ft. - NAVD)

Time Steps (hr.)	R1 - R44	R45 - R62	R63 - R159	R160 - R183
0.00	-0.85	-0.85	-0.85	-0.85
0.50	-1.12	-1.12	-1.12	-1.12
1.00	-1.38	-1.38	-1.38	-1.38
1.50	-1.60	-1.60	-1.60	-1.60
2.00	-1.76	-1.76	-1.76	-1.76
2.50	-1.85	-1.85	-1.85	-1.85
3.00	-1.90	-1.90	-1.90	-1.90
3.50	-1.88	-1.88	-1.88	-1.88
4.00	-1.82	-1.82	-1.82	-1.82
4.50	-1.70	-1.70	-1.70	-1.70
5.00	-1.53	-1.53	-1.53	-1.53
5.50	-1.33	-1.33	-1.33	-1.33
6.00	-1.14	-1.14	-1.14	-1.14
6.50	-0.93	-0.93	-0.93	-0.93
7.00	-0.72	-0.72	-0.72	-0.72
7.50	-0.51	-0.51	-0.51	-0.51
8.00	-0.31	-0.31	-0.31	-0.31
8.50	-0.11	-0.11	-0.11	-0.11
9.00	0.07	0.07	0.07	0.07
9.50	0.21	0.21	0.21	0.21
10.00	0.32	0.32	0.32	0.32
10.50	0.38	0.38	0.38	0.38
11.00	0.42	0.42	0.42	0.42
11.50	0.43	0.43	0.43	0.43
12.00	0.43	0.43	0.43	0.43
12.50	0.45	0.45	0.45	0.45
13.00	0.98	1.01	0.86	0.83
13.50	1.17	1.20	1.02	0.99
14.00	1.43	1.47	1.25	1.22
14.50	1.82	1.87	1.59	1.55
15.00	2.29	2.35	2.00	1.95
15.50	2.78	2.85	2.43	2.36
16.00	3.33	3.41	2.91	2.83
16.50	3.84	3.93	3.36	3.26
17.00	4.26	4.37	3.73	3.62
17.50	4.56	4.68	3.99	3.88
18.00	4.72	4.84	4.13	4.01
18.50	4.71	4.83	4.12	4.01
19.00	4.59	4.70	4.01	3.90
19.50	4.38	4.48	3.83	3.72

20.00	4.08	4.19	3.57	3.47
20.50	3.74	3.83	3.27	3.18
21.00	3.31	3.39	2.89	2.81
21.50	2.80	2.87	2.45	2.38
22.00	2.25	2.31	1.97	1.91
22.50	1.69	1.73	1.48	1.43
23.00	1.02	1.05	0.89	0.87
23.50	0.35	0.36	0.31	0.30
24.00	-0.15	-0.15	-0.15	-0.15
24.50	-0.48	-0.48	-0.48	-0.48
25.00	-0.77	-0.77	-0.77	-0.77
25.50	-1.03	-1.03	-1.03	-1.03
26.00	-1.26	-1.26	-1.26	-1.26
26.50	-1.43	-1.43	-1.43	-1.43
27.00	-1.54	-1.54	-1.54	-1.54
27.50	-1.60	-1.60	-1.60	-1.60
28.00	-1.63	-1.63	-1.63	-1.63
28.50	-1.61	-1.61	-1.61	-1.61
29.00	-1.57	-1.57	-1.57	-1.57
29.50	-1.54	-1.54	-1.54	-1.54
30.00	-1.50	-1.50	-1.50	-1.50
30.50	-1.45	-1.45	-1.45	-1.45
31.00	-1.39	-1.39	-1.39	-1.39
31.50	-1.33	-1.33	-1.33	-1.33
32.00	-1.28	-1.28	-1.28	-1.28
32.50	-1.21	-1.21	-1.21	-1.21
33.00	-1.14	-1.14	-1.14	-1.14
33.50	-1.07	-1.07	-1.07	-1.07
34.00	-1.00	-1.00	-1.00	-1.00
34.50	-0.90	-0.90	-0.90	-0.90
35.00	-0.80	-0.80	-0.80	-0.80
35.50	-0.68	-0.68	-0.68	-0.68
36.00	-0.56	-0.56	-0.56	-0.56

Sarasota County - Adjusted 25-year Storm Surge Elevation Hydrograph Time Series Values for SBEACH (ft. - NAVD)

Time Steps (hr.)	R1 - R44	R45 - R62	R63 - R159	R160 - R183
0.00	-0.19	-0.19	-0.19	-0.19
0.50	-0.46	-0.46	-0.46	-0.46
1.00	-0.72	-0.72	-0.72	-0.72
1.50	-0.93	-0.93	-0.93	-0.93
2.00	-1.07	-1.07	-1.07	-1.07
2.50	-1.16	-1.16	-1.16	-1.16
3.00	-1.23	-1.23	-1.23	-1.23
3.50	-1.27	-1.27	-1.27	-1.27
4.00	-1.24	-1.24	-1.24	-1.24
4.50	-1.16	-1.16	-1.16	-1.16
5.00	-1.04	-1.04	-1.04	-1.04
5.50	-0.90	-0.90	-0.90	-0.90
6.00	-0.76	-0.76	-0.76	-0.76
6.50	-0.60	-0.60	-0.60	-0.60
7.00	-0.42	-0.42	-0.42	-0.42
7.50	-0.25	-0.25	-0.25	-0.25
8.00	-0.11	-0.11	-0.11	-0.11
8.50	-0.01	-0.01	-0.01	-0.01
9.00	0.05	0.05	0.05	0.05
9.50	0.07	0.07	0.07	0.07
10.00	0.06	0.06	0.06	0.06
10.50	0.03	0.03	0.03	0.03
11.00	-0.01	-0.01	-0.01	-0.01
11.50	-0.03	-0.03	-0.03	-0.03
12.00	-0.05	-0.05	-0.05	-0.05
12.50	-0.04	-0.04	-0.04	-0.04
13.00	0.08	0.09	0.07	0.07
13.50	0.36	0.38	0.32	0.31
14.00	0.79	0.83	0.70	0.68
14.50	1.33	1.40	1.19	1.16
15.00	1.95	2.05	1.74	1.69
15.50	2.68	2.83	2.40	2.33
16.00	3.48	3.66	3.11	3.02
16.50	4.27	4.49	3.82	3.70
17.00	4.98	5.24	4.45	4.32
17.50	5.51	5.80	4.93	4.79
18.00	5.81	6.12	5.20	5.05
18.50	5.88	6.19	5.26	5.11
19.00	5.76	6.06	5.15	5.00
19.50	5.46	5.75	4.89	4.74

20.00	5.09	5.36	4.55	4.42
20.50	4.58	4.82	4.10	3.98
21.00	3.98	4.19	3.56	3.45
21.50	3.32	3.49	2.97	2.88
22.00	2.60	2.74	2.33	2.26
22.50	1.83	1.93	1.64	1.59
23.00	1.07	1.12	0.95	0.93
23.50	0.36	0.37	0.32	0.31
24.00	-0.19	-0.19	-0.19	-0.19
24.50	-0.53	-0.53	-0.53	-0.53
25.00	-0.84	-0.84	-0.84	-0.84
25.50	-1.09	-1.09	-1.09	-1.09
26.00	-1.24	-1.24	-1.24	-1.24
26.50	-1.30	-1.30	-1.30	-1.30
27.00	-1.26	-1.26	-1.26	-1.26
27.50	-1.17	-1.17	-1.17	-1.17
28.00	-1.04	-1.04	-1.04	-1.04
28.50	-0.88	-0.88	-0.88	-0.88
29.00	-0.69	-0.69	-0.69	-0.69
29.50	-0.49	-0.49	-0.49	-0.49
30.00	-0.31	-0.31	-0.31	-0.31
30.50	-0.14	-0.14	-0.14	-0.14
31.00	0.01	0.01	0.01	0.01
31.50	0.13	0.13	0.13	0.13
32.00	0.21	0.21	0.21	0.21
32.50	0.24	0.24	0.24	0.24
33.00	0.22	0.22	0.22	0.22
33.50	0.14	0.14	0.14	0.14
34.00	0.02	0.02	0.02	0.02
34.50	-0.15	-0.15	-0.15	-0.15
35.00	-0.32	-0.32	-0.32	-0.32
35.50	-0.49	-0.49	-0.49	-0.49
36.00	-0.63	-0.63	-0.63	-0.63

APPENDIX E

15- and 25-year Horizontal Erosion Distances for Sarasota County

MHW = 0.3 ft. (NAVD)

+ : Erosion

- : Accretion

15-year Horizontal Erosion Distances at Contours (ft. – NAVD)

Range	MHW	3'	5'	7'
T1	12.6	15.6	-4.1	11.5
R2	13.5	22.7	-1.7	3.7
R3A	12.6	13.9	9.7	2.1
R4	7.3	12.4	21.3	
R5A	13.4	17.3	19.6	-3.3
T6	6.9	14.8	19.5	3.9
R7	15.5	15.8	16.4	4.8
R8	8.9	13.3	18.9	
R9	8.8	16.0	12.9	
R10	7.7	15.7	15.8	
R11	7.7	16.2	25.9	
R12	5.8	12.1	22.9	15.4
R13	-5.0	16.9	-1.5	1.3
R14	1.1	11.3	17.0	7.7
T15	12.2	-3.3	14.5	0.3
R16	10.3	26.0	0.9	
R17	2.7	7.7	12.1	
R18	0.3	18.6	5.4	
R19	4.8	21.9	0.9	
R20	4.8	24.7	44.8	-16.2
R21	7.8	29.1	19.2	-6.3
T22	6.5	22.9	4.7	0.5
T23	9.7	23.9	10.1	10.5
R24	7.6	22.9	36.3	
R25	14.2	8.4	21.4	16.0
R26	13.5	14.8	11.3	0.0
R27	13.3	15.1	9.6	
R28	10.3	40.2	15.8	
R29	7.2	29.4		
R30	N/A			
R31	-1.0	36.0	65.8	
R32	39.9	-0.8	-6.2	4.5
R33	28.5	-1.9	1.2	3.2
R34	30.2	0.7		
R35	-4.0	4.9	122.5	
T36	-10.2	-1.7	37.0	
R37	10.7	20.4	19.4	5.2
R38	11.0	8.2	15.5	29.9
R39	22.5	-12.4	26.4	67.8
R40	27.8	-9.7	10.1	
R41	23.4	-3.6	18.1	

R42	18.0	-2.0	2.5	-28.1
R43	15.7	10.1		
R44	15.5	13.1		
R45	N/A			
T46	29.8	2.8		
R47	23.3	-20.2	1.8	
R48	2.6	105		
R49	22.2	5.2		
R50	11.6	30		
T51	7.1	23.5		
R52	18.8	3.0	6.6	
R53	17.0	33.3	2.5	
R54	17.2	-17.1		
R55	7.8	0.0	1.8	
R56	6.5	1.7	17.6	
R57	17.9	-7.8	19.9	
R58	24.4	-5.0	5.2	
R59	14.7	-8.9		
R60	16.1	-1.3	24.0	
R61	10.3	1.1		
R61A	3.5	3.0	46.0	
R62	-20.0	9.4	29.7	46.4
R63	-30.3	-17.4	-0.4	14.4
R64	1.5	31.1	52.8	
R65	3.0	45.0	80	
R66	16.5	37.2	54.3	50.1
R67	5.8	16.2	8.8	17.4
R68	8.4	19.5	30.7	0.2
R69	8.5	25.9	33.4	-20.6
R70	8.4	27.2	44.3	-23.1
R71	9.5	27.1	38.1	-19.6
R72	8.0	18.3	29.3	
R73	8.4	20.6	32.7	2.2
R74	8.1	16.2	24.4	2.0
R75	9.5	17.9	18.2	2.1
R76	14.7	22.1	13.5	-1.1
R77	5.1	30.4	63.4	
R78	10.8	23.6	29.4	2.2
R79	8.4	27.8	5.1	-1.0
R80	4.5	29.0	3.6	0.5
R81	12.0	23.8	0.7	10.7
R82	8.2	8.1	8.2	12.9
R83	9.5	6.7	12.7	22.3
R84	10.2	13.9	14.1	15.0

R85	6.9	13.4	18.0	8.3
R86	9.6	19.1	22.1	
R87	2.4	12.4	12.4	20.4
R88	15.7	22.9	9.5	8.3
R89	22.7	11.3	6.0	4.1
R90	10.1	9.4	8.8	9.9
R91	11.2	21.7	9.9	6.0
R92	12.4	18.0	8.1	10.4
R93	16.3	25.4	6.0	4.0
R94	13.2	21.8	7.7	6.4
R95	12.3	17.8	10.2	6.5
R96	-11.3	-1.0	-3.4	6.3
R97	-2.9	-0.3	4.5	12.1
R98	-14.7	-7.5	6.5	22.9
R99	-7.9	1.1	11.2	24.0
R100	-4.3	5.6	14.6	26.6
R101	-0.4	6.8	19.2	27.5
R102	1.1	1.6	11.8	18.3
R103	10.4	12.4	19.2	23.6
R104	16.0	24.8	14.0	13.8
R105	17.0	25.2	20.2	22.5
R106	11.4	21.2	20.3	26.5
R107	7.1	22.0	22.6	28.2
R108	13.4	25.3	22.2	18.5
R109	19.1	25.7	20.7	18.3
R110	12.8	18.6	14.3	2.4
R111	17.3	32.5	17.1	12.7
R112	14.8	23.2	11.8	
T113	11.0	17.8	15.5	0.8
R114	7.6	22.0	18.5	1.1
R115	38.9	62.7		
R116	-3.5	13.4	26.3	38.6
R117	5.0	15.2	27.4	24.7
R118	12.3	21.2	14.2	6.5
R119	15.3	18.2	23.2	
R120	16.5	19.8	25.0	4.6
R121	17.2	19.9	7.7	10.5
T122	8.1	17.2	21.9	26.8
R123A	11.9	12.9	21.7	30.5
R124	9.2	16.0	24.4	32.2
R125	5.2	12.6	22.1	34.5
R126	18.3	20.9	23.5	0.4
T127	13.1	19.6	27.9	26.7
R128	16.4	26.7	55.0	

R129	15.3	23.2	15.4	0.9
R130	18.3	29.8	10.6	4.1
T131	10.5	24.5	9.7	7.0
R132	16.0	19.2	14.1	18.1
R133	14.8	28.7	6.6	
T134	17.6	29.6	16.5	
R135	16.9	21.1	29.5	
R136	10.0	22.9	40.3	
R137	4.9	10.4	27.9	39.4
R138	21.7	-2.2	10.8	
R139	9.4	6.0	10.4	16.2
R140	0.7	2.6	15.8	
R141	-3.1	-2.2	5.6	14.0
R142	9.3	-9.2	-1.4	7.1
R143	8.1	-6.6	-7.3	6.6
R144	13.1	4.7	7.0	
T145	7.1	-0.7	-3.7	8.2
R146	-4.5	-10.4	-1.1	9.2
R147	4.6	4.8	14.1	34.4
R148	2.1	-0.7	10.2	21.3
T149	9.2	7.1	28.7	46.7
R150	4.5	3.6	6.9	13.7
R151	11.9	5.1	16.3	26.4
R152	2.7	17.5	20.5	33.8
R153	13.1	20.1	12.3	19.1
R154	13.3	20.4	3.5	-0.2
R155	15.6	25.7	13.9	12.2
R156	12.4	23.0	12.3	-26.1
R157	12.2	33.8	14.6	-9.9
R158	12.1	20.1	8.6	-7.3
R159	9.4	12.3	-2.4	-2.4
R160	5.0	4.4	-1.2	6.9
R161	8.7	6.0	1.9	8.2
R162	5.5	-0.1	1.7	5.5
R163	17.2	10.9	19.0	
R164	2.4	-5.9	2.2	10.6
R165	17.5	8.8	11.4	11.1
T166	20.6	9.7	9.8	7.5
R167	13.6	7.7	6.5	12.5
R168	12.2	9.9	10.8	5.3
R169	12.0	12.7	9.5	3.1
R170	6.9	10.1	6.4	18.8
R171	12.9	16.0	9.9	12.8
R172	11.2	10.5	9.7	18.7

R173	11.3	17.5	16.8	-8.8
R174	13.3	12.8	28.5	40.3
R175	21.8	17.8	6.9	11.1
R176	18.8	27.3	8.6	
R177	16.0	30.6	4.2	1.0
R178	9.5	21.1	12.6	9.7
R179	15.4	16.6	7.4	
R180	-2.7	-3.0	5.3	15.4
R181	11.1	2.7	9.2	20.5
R182	5.2	6.7	19.8	27.7
R183	-5.6	-6.8	7.9	15.9

25-year Horizontal Erosion Distances at Contours (ft. – NAVD)

Range	MHW	3'	5'	7'
T1	10.6	14.0	-4.3	13.1
R2	14.3	21.7	3.5	21.1
R3A	10.7	13.6	16.4	38.7
R4	6.3	11.5	22.4	
R5A	12.7	18.4	30.4	47.3
T6	5.8	13.9	21.4	10.8
R7	11.3	15.6	18.4	19.8
R8	7.6	14.0	20.9	
R9	6.4	16.5	18.8	4.8
R10	5.2	15.1	22.8	
R11	5.9	16.5	35.1	
R12	3.8	12.7	34.4	
R13	-5.6	17.1	-0.7	14.6
R14	-0.2	10.1	19.6	23.5
T15	11.4	0.4	15.3	3.8
R16	9.9	24.7	1.2	
R17	2.0	8.1	12.8	2.2
R18	-2.1	24.2	26.2	
R19	1.5	22.3	2.4	11.6
R20	2.2	31.9	42.0	10.1
R21	5.7	30.5	20.9	2.6
T22	3.5	22.9	5.3	11.3
T23	8.3	25.1	14.5	43.1
R24	7.8	22.8	27.5	
R25	14.5	7.9	18.6	10.8
R26	12.4	16.2	16.0	22.0
R27	12.6	11.6	12.2	
R28	8.1	40.7	14.2	
R29	4.8	28.4		
R30	N/A			
R31	-1.1	35.0	62.7	
R32	36.4	-9.5	42	
R33	38.6	-4.9	-2.4	7.1
R34	29.5	-0.2		
R35	-2.9	4.4	92.3	
T36	-13.1	-1.7	31.3	
R37	7.8	20.9	23.4	31.6
R38	10.4	8.0	20.6	64.9
R39	21.7	-12.7	25.6	66.5
R40	27.4	-5.5	15.4	
R41	22.9	-1.2	16.5	

R42	19.0	-1.6	2.5	-27.2
R43	13.8	21.9		
R44	22.0	7.0		
R45	N/A			
T46	30.0	7.2		
R47	22.6	-13.0	0.6	
R48	7.0	91.2		
R49	25.5	-17.6		
R50	14.2	30		
T51	6.4	25.0		
R52	19.6	18.3	31.0	
R53	16.1	43.2	-5.6	
R54	11.7	0.4		
R55	9.1	-0.1	-0.5	
R56	6.6	1.1	16.8	
R57	18.5	-5.6	20.0	
R58	25.4	-8.4	6.2	
R59	15.4	-8.6		
R60	16.6	-1.0	37.7	
R61	10.9	0.4		
R61A	5.3	0.8	64.7	
R62	-21.4	8.1	30.0	49.0
R63	-32.7	-18.0	-0.5	16.5
R64	0.7	31.9	53.7	
R65	4.0	44.3	80	
R66	15.3	40.4	76.2	50
R67	4.4	18.1	14.1	26.3
R68	7.2	20.6	35.0	3.6
R69	7.3	25.9	34.9	-11.5
R70	7.4	28.7	47.3	-13.3
R71	8.2	27.1	40.1	-8.5
R72	6.9	19.1	31.6	
R73	6.8	20.4	32.4	3.5
R74	7.0	17.3	25.5	3.3
R75	8.9	20.1	24.9	14.0
R76	13.5	25.0	23.4	28.7
R77	4.1	28.7	56.7	
R78	9.9	24.9	29.9	4.9
R79	6.8	28.2	8.3	4.8
R80	2.7	28.9	0.8	1.9
R81	11.0	22.0	3.8	17.9
R82	4.0	4.3	12.6	29.5
R83	9.6	7.6	13.0	25.2
R84	9.2	13.5	13.8	16.9

R85	5.9	13.5	17.8	10.3
R86	8.8	18.9	20.6	
R87	1.7	13.2	12.6	22.8
R88	15.3	24.0	9.1	11.0
R89	22.3	11.1	9.4	16.6
R90	9.3	10.1	8.1	12.0
R91	10.4	23.0	12.9	12.6
R92	12.1	19.2	11.3	16.6
R93	16.4	26.0	5.2	6.2
R94	12.8	22.1	6.8	8.7
R95	11.5	18.1	9.8	8.1
R96	-12.1	-1.1	-3.4	8.1
R97	-3.2	-0.6	4.7	14.2
R98	-16.5	-8.7	6.7	25.1
R99	-8.0	1.2	10.9	25.4
R100	-4.9	6.0	14.1	27.7
R101	-0.8	7.7	19.1	29.7
R102	0.4	2.4	11.7	20.1
R103	9.9	14.5	24.0	34.0
R104	15.5	28.7	21.0	27.1
R105	16.3	28.3	26.3	36.2
R106	11.2	23.5	26.7	41.0
R107	6.6	24.3	25.5	38.7
R108	14.2	26.9	25.2	29.6
R109	17.8	28.8	28.0	36.3
R110	11.9	20.1	15.3	8.8
R111	16.7	34.1	27.6	46.8
R112	13.3	24.0	13.6	
T113	10.1	19.3	22.0	20.7
R114	7.4	21.6	23.8	9.9
R115	37.6	63.4		
R116	-4.1	13.0	27.0	40.8
R117	4.4	14.7	28.5	32.1
R118	11.5	20.9	14.4	9.8
R119	14.0	18.7	24.4	
R120	14.4	21.0	25.3	7.8
R121	14.1	20.5	14.7	22.9
T122	7.4	16.4	22.1	30.3
R123A	11.2	13.8	25.8	42.7
R124	8.0	17.0	28.8	42.6
R125	3.9	12.0	23.0	38.4
R126	17.4	21.9	27.4	9.0
T127	8.8	19.6	34.1	39.2
R128	14.9	28.7	55.0	

R129	16.6	23.2	16.6	2.6
R130	18.9	29.8	11.5	7.3
T131	9.9	23.9	10.5	12.9
R132	13.6	18.1	16.3	25.3
R133	13.9	29.5	6.8	
T134	15.9	30.0	15.2	
R135	15.3	22.1	32.2	
R136	9.0	24.4	40.9	
R137	6.3	10.8	27.4	42.6
R138	22.0	-1.9	11.3	
R139	8.7	5.5	10.5	19.7
R140	-0.1	3.1	15.6	
R141	-2.9	-2.2	5.5	15.9
R142	8.0	-8.7	-1.3	9.1
R143	7.7	-6.4	-7.2	8.7
R144	12.9	4.9	7.5	
T145	4.1	-1.8	-3.0	12.3
R146	-4.1	-10.4	-0.9	11.3
R147	4.5	4.7	13.9	43.0
R148	1.9	-1.2	9.9	25.1
T149	8.9	7.7	39.8	66.0
R150	2.7	3.3	13.4	27.3
R151	12.7	6.1	19.8	35.7
R152	2.1	18.8	28.0	54.3
R153	12.6	21.3	17.5	34.1
R154	13.1	20.7	10.5	10.1
R155	14.8	27.7	20.2	30.4
R156	12.1	24.3	27.9	-22.8
R157	12.2	35.2	16.4	-8.4
R158	11.4	20.4	10.7	-7.2
R159	8.7	12.0	-2.0	-0.6
R160	5.3	3.8	-1.2	8.8
R161	8.2	6.7	2.3	10.7
R162	3.2	0.2	2.0	8.1
R163	17.2	12.0	26.3	
R164	2.4	-4.7	2.2	12.2
R165	17.2	11.0	15.5	18.4
T166	19.8	9.8	9.1	9.5
R167	12.8	9.1	6.6	14.7
R168	11.0	9.4	10.2	8.4
R169	11.1	13.1	8.9	5.0
R170	7.2	10.5	5.7	20.2
R171	12.6	18.6	14.2	19.7
R172	8.2	11.1	11.7	25.6

R173	10.3	20.2	22.4	1.2
R174	12.7	14.9	33.1	51.7
R175	20.6	20.5	17.0	31.3
R176	18.6	26.6	10.4	
R177	18.5	30.3	0.5	2.3
R178	7.8	20.9	15.0	15.6
R179	14.9	16.4	8.4	
R180	-3.1	-2.9	5.3	17.2
R181	9.3	3.3	10.4	26.7
R182	5.3	6.4	20.3	34.5
R183	-6.7	-7.9	8.5	19.1